

Abstracts

Oral presentations

1 NON-COMPACTION OF VENTRICULAR MYOCARDIUM, CLINICAL AND ECHOCARDIOGRAPHIC FEATURES OF 8 CASES

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Non-compaction of the ventricular myocardium (NVM) is a rare cardiomyopathy characterized by prominent trabeculations and deep intertrabecular recesses. In this study 8 cases of NVM were followed prospectively. The age of presentation ranged from birth to 10 months. Male to female ratio was 1:3. Clinical presentation was variable; one asymptomatic infant (patient 1) was identified incidentally because of associated patent ductus arteriosus. One infant (patient 2) presented with mild congestive heart failure attributed to associated multiple ventricular septal defects and three patients with isolated NVM (patients 3, 4 and 5) presented with heart failure. In a further three patients (patients 6, 7 and 8) NVM was associated with complex cyanotic congenital heart disease. In all patients diagnosis was confirmed echocardiographically by calculating a ratio of non-compacted to compacted layer thickness of 2 or more. In patients 1 and 2 the ventricular function was normal while it was impaired in the others. Short-term outcome reflected the heterogeneous nature of the disease; patient 1 is doing well with a normal ventricular function, patient 2 showed clinical improvement of congestive heart failure. Patient 3 died with severe myocardial dysfunction at the age of 7 days. Patients 4 and 5 are alive with severely impaired function. Patient 6 died with ventricular arrhythmia following a Blalock-Taussig shunt insertion. Patients 7 and 8 are alive with impaired myocardial function.

NVM may not be as rare as is thought. It should be considered in infants presenting with either congenital heart disease or cardiomyopathy in whom the echocardiographic features suggest excessively prominent trabeculations with or without left ventricular dysfunction.

2 PREDICTION OF SYMPTOM ONSET IN AORTIC STENOSIS: BASELINE AND SERIAL ECHOCARDIOGRAPHY IN 97 PATIENTS

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Background: It remains unclear which echocardiographic variables are of prognostic significance in asymptomatic aortic stenosis (AS). This prospective study aimed to identify variables from baseline and serial echocardiography that differed in patients who subsequently became symptomatic.

Methods: 97 patients aged 65 years (range 27–81) were studied. All denied symptoms and had normal left ventricular systolic function. A transthoracic echocardiographic study was made at baseline and six monthly intervals. Mean pressure drop was calculated using the Bernoulli formula and effective orifice area (EOA) from the continuity equation. Patients were reviewed and questioned for symptoms every six months.

Results: Mean follow up was 20 months (range 5–30). 80 patients had 2 or more echocardiograms. 24 patients developed symptoms and 73 remained asymptomatic. Peak aortic velocity and mean resistance were significantly greater for patients developing symptoms whilst EOA and left ventricular long axis excursion (LAE) were lower. There were no differences in rate of change of peak aortic velocity or EOA.

Conclusion: Baseline effective orifice area, peak aortic velocity, mean resistance and left ventricular long axis function were significantly different in patients with AS who became symptomatic. However, the rate of change of peak velocity and EOA did not have prognostic significance.

3 CARDIAC CAVITY SIZE INDEX TO DIAMETER OF THE SUBAORTIC ANNULUS

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Introduction: The aortic velocity integral remains constant during growth in childhood. This suggests that the aorta grows to accommodate the change in cardiac output necessary for the metabolic demands of the body. It may be logical to use the size of the aorta as a physiological index in place of body surface area.

Methods: We therefore assessed aortic size and left ventricular structure in 215 healthy children (112 boys and 103 girls), aged between 8 and 9 years. Echocardiograms were performed with an Acuson 128 XP system using a 3.5 MHz probe. Cavity dimensions were averaged over 5 consecutive cardiac cycles using the ASE convention.

Results: There were wide differences in height (115–157 cm) and weight (20.0–55.8 kg). Left atrial diameter ranged between (LA 1.60–3.09 cm) and left ventricular diastolic diameter between (LVDd 3.35–4.83 cm). Both left atrial and left ventricular diameters were correlated with body surface area: LA $r=0.502$, $p<0.001$, LVDd $r=0.632$, $p<0.001$. There were similar correlation with subaortic annulus diameter: LA $r=0.365$, $p<0.001$, LVDd $r=0.530$, $p<0.001$. The correlations with body surface area were no longer apparent after indexing the raw dimension to subaortic annulus diameter: LA/annulus $r=0.109$, $p=0.10$, LVDd/annulus $r=0.144$, $p=0.05$.

Conclusion: Indexing to subaortic annulus diameter is a simple and convenient method of adjusting cardiac chambers for body size during childhood and this may be a clinically useful alternative to indexing to body surface area.

4 BIVENTRICULAR PACING: THE EFFECTS OF LEAD POSITION AND PACING INTERVALS ON CARDIAC PERFORMANCE

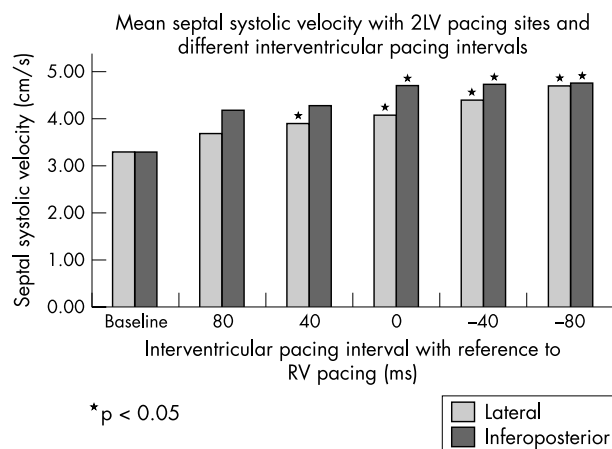
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Introduction: In patients with heart failure (HF) and left bundle branch block (LBBB), left ventricular (LV) asynchrony contributes to systolic impairment. Biventricular pacing (BVP) is now an established treatment, however, the optimal LV lead position and interventricular pacing interval (IPI) have yet to be established. Tissue Doppler imaging (TDI) was used to assess the effects of different LV lead positions and IPIs on regional LV systolic function.

Methods: 9 patients (age 74 ± 7 years; 4 with ischaemic heart disease and 5 with dilated cardiomyopathy) with chronic HF (NYHA III–IV, LVEF $<30\%$) and LBBB (QRS 169 ± 26 ms) were studied. Pulsed wave TDI were measured at the level of the mitral valve annulus at baseline and during BVP. Temporary BVP from RV and 2 different LV positions at 5 IPIs were examined: RV-LV intervals were set at +80, +40, 0, –40 and –80 ms with reference to RV pacing. LV pacing was performed from the lateral (n=9) and the inferoposterior walls (n=7).

Abstract 2

Variable	Symptoms Mean (SD)	No symptoms Mean (SD)	P value (T test)
Peak aortic vel (m/s)	4.0 (0.6)	3.6 (0.7)	0.006
Mean press drop (mmHg)	37.7 (14.0)	30.8 (15.1)	0.051
EOA (cm ²)	0.74 (0.14)	0.96 (0.27)	<0.0001
Mean resistance (dyne.s.cm ⁻²)	236 (85)	175 (92)	0.006
Septal LAE (cm)	0.9 (0.3)	1.1 (0.3)	0.01
Lateral LAE (cm)	1.0 (0.3)	1.3 (0.3)	0.003
ΔPeak vel/visit (m/s)	+0.1 (0.3)	+0.1 (0.3)	0.9
ΔEOA/visit (cm ²)	–0.07 (0.07)	–0.05 (0.08)	0.4



Results: Systolic velocities for septum at RV-LV 0, -40 and -80ms and posterior wall at -80ms were significantly increased from baseline with both LV pacing sites. Neither LV pacing site nor IPI significantly altered lateral or RV wall systolic velocities.

Conclusion: During BVP, septal and posterior wall systolic velocities are increased irrespective of LV pacing site. Greatest improvement in LV systolic function occurs when LV precedes RV pacing.

5 ECHOCARDIOGRAPHIC CHARACTERISTICS OF DYSSYNCHRONY CAUSED BY LEFT BUNDLE BRANCH BLOCK IN PATIENTS UNDERGOING CARDIAC RESYNCHRONISATION PACING

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Background: There is convincing evidence that cardiac resynchronisation pacing (CRT) reduces morbidity in patients with class III/IV heart failure, left ventricular ejection (LVEF) $\leq 35\%$ and left bundle branch block (LBBB), width ≥ 150 ms. CRT improves cardiac efficiency by improving atrial priming, reducing mitral regurgitation and LV volumes, increasing LVEF and forward cardiac output. However, up to one third of patients selected by the above criteria do not respond as measures of electrical delay may not identify the mechanical abnormality that can be reversed by CRT. We propose that routine echo may aid selection by identifying mechanical dyssynchrony in LBBB.

Methods: We studied the echo characteristics of LBBB in 16 heart failure patients indicated for CRT (group A) and 15 patients investigated for chest pain (group B). LV wall motion score index (WMSI), the average score (1=normokinesis, 2=hypokinesis, 3=akinesis, 4=dyskinesis) of 16 LV segments, was used to detect the dyskinesis associated with LBBB. LVEF (Method of disks) in the 4 and 2 chamber views were obtained to study regional contractile dyssynchrony. Doppler cardiac output (CO) and interventricular pre-ejection delay were measured.

Abstract 5

Means \pm SD	LVWMSI	LVEF4c,%	LVEF2c,%	CO, l/min
Group A	2.51 \pm 0.33	24.5 \pm 6.5	26.3 \pm 8.6	3.3 \pm 1.3
Group B	1.43 \pm 0.34	48.6 \pm 12.7	56.3 \pm 9.7	5.5 \pm 2.0
P value	<0.0001	<0.0001	<0.0001	0.004

Results: Group A patients had mean LV diastolic diameters of 6.4 \pm 1.1 cm and significantly worse WMSI, LVEF and CO than group B. In these CRT patients, interventricular dyssynchrony was detected as left sided pre-ejection delays of 50 \pm 23 ms. Atrioventricular dyssynchrony was manifest as presystolic mitral regurgitation in 56% and as a uniphasic mitral Doppler inflow due to e/a fusion in 50%. LV dyssynchrony was seen with an average of 6.7 \pm 3.7 LV segments showing paradoxical contraction, particularly in the 4 and 3 chamber

views. 14/16 group A patients, compared to 3/15 group B patients exhibited significant paradoxical LV contraction.

Conclusion: Routine echo can detect mechanical evidence of interventricular, atrioventricular and LV evidence of dyssynchrony associated with LBBB.

6 THE DETECTION OF SYMPTOMATIC LEFT VENTRICULAR INTRACAVITY GRADIENTS DURING DOBUTAMINE STRESS ECHOCARDIOGRAPHY

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Dobutamine stress echocardiography (DSE) is a routine investigation to assess for the presence of reversible myocardial ischaemia. However, there are instances where the patient's symptoms are reproduced despite the absence of any wall motion abnormality. It is in this subgroup of patients that left ventricular cavity dynamics were further assessed in response to stress. 59 patients had a DSE over a 5-month period, utilising a graded DSE protocol. 18 were positive and 41 negative for wall motion abnormalities. In 5 out of 20 patients with reproduction of their symptoms but normal wall motion, marked systolic cavity obliteration was noted at peak stress. In these patients, continuous wave Doppler (CW) was performed to evaluate intracavity gradients (ICG) or for left ventricular outflow tract obstruction (LVOTO). CW monitoring was also continued during recovery. Baseline characteristics of these 5 patients: 2 male, 3 female, av. age 54 (range 35-65), LVH-severe (2), moderate (1), mild (1), normal (1). Peak ICG range 50-143 mmHg (mean 119). SAM present in 3/5. Symptoms: chest pain (2), dyspnoea (3). All 5 had systolic cavity obliteration resulting in a significant ICG and/or LVOTO. These features resolved fully during recovery in all patients. These cases demonstrate the anatomical (LV wall thickness and cavity size) and physiological (ICG and SAM of MV) parameters that can be assessed during a DSE that may account for the patient's symptoms if wall motion is normal. In 25% of patients (i.e. 5 out of 20) with a negative but symptomatic DSE, these haemodynamic anomalies were identified. There appeared to be no correlation between the presence and degree of LVH and the development or degree of any ICG or LVOTO. We recommend the monitoring such left ventricular dynamics in these patients.

7 MODERATE OR SEVERE AORTIC STENOSIS? DOBUTAMINE STRESS ECHOCARDIOGRAPHY IN PATIENTS WITH MILD SYMPTOMS

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Background: Distinguishing moderate from severe aortic stenosis (AS) in patients with mild symptoms can be difficult. Previous studies suggested that dobutamine stress echocardiography could help identify severe AS. We compared resting measures and the mean pressure drop/flow slope (PFS) to surgical findings.

Method: 25 patients with isolated AS were studied because of mild symptoms and uncertainty over the severity of stenosis. Resting transthoracic echocardiography was repeated. Dobutamine was infused in increments of 5 mcg/kg/min to a maximum of 40 mcg/kg/min. Doppler studies were repeated at each stage. Transaortic flow at each stage was plotted against mean pressure drop and the PFS derived from the linear regression equation. The anatomic degree of stenosis on visual inspection at surgery was recorded where noted as moderate or severe.

Results: Resting peak transaortic velocity was 3.5 \pm 0.7 m/s, mean pressure drop 29.7 \pm 12.7 mmHg and effective orifice area (EOA) 0.9 \pm 0.2 cm². Resting left ventricular function was normal in all cases. There were no complications during dobutamine stress. There was a linear mean pressure/flow slope in 22 cases, mean 0.14 mmHg/mls⁻¹. 17 patients were subsequently listed for surgery and 14 underwent valve replacement, of which 9 were described as having severe and 4 moderate stenosis. Patients with surgically severe vs moderate stenosis had similar peak transaortic velocity (3.8 vs 3.5m/s, p=0.6), mean pressure drop (34.0 vs 28.3 mmHg, p=0.4) and resting EOA (0.78 vs 0.95 cm², p=0.18). PFS was significantly greater in severe stenosis (0.19 vs 0.06 mmHg/mls⁻¹, p=0.015).

Conclusion: This small study suggests that dobutamine stress echocardiography can be used in management of patients with apparently moderate aortic stenosis and equivocal symptoms. A PFS of >0.1 mmHg/mls⁻¹ reliably identified patients with anatomically severe stenosis at surgery.

8 BRAIN NATRIURETIC PEPTIDE IS A USEFUL MARKER OF LEFT VENTRICULAR DYSFUNCTION FOLLOWING MITRAL VALVE REPAIR

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Background: Following successful mitral valve repair surgery, even mild left ventricular (LV) dysfunction carries a poor prognosis. One of the most powerful predictors of this is reduced pre-operative ejection fraction (EF). We assessed the role of baseline Brain Natriuretic Peptide (BNP) as an additional marker of LV dysfunction 6 months following mitral repair.

Methods: 33 patients had pre-operative N-terminal pro-BNP measured using a commercial enzyme-linked immunosorbent assay. All patients had severe mitral regurgitation (Regurgitant fraction >55%) due to degenerative valve disease. Patients with hypertension, previous myocardial infarction, renal or hepatic disease were excluded. Patients who had peri-operative infarction or unsuccessful repair as evaluated by a pre-discharge echocardiogram were also excluded. LV EF was calculated by biplane method of discs immediately prior to surgery and repeated after 6 months. An EF of <50% was considered significant.

Results: Baseline patient data was as follows: mean (SD) age 62 (13) years, 73% sinus rhythm and 3 patients with concomitant coronary disease. Mean (SD) BNP was 255 (236) fmol/ml. Post-operative EF was significantly less than at baseline {mean(SD) 60(8)% vs 52(11)% respectively; $p<0.001$ }. At 6 month follow-up 1 patient died and 11 had an EF<50%. In the post-operative LV dysfunction group, baseline BNP concentration was significantly greater and pre-operative EF was significantly lower {mean(SD) 420(298) vs 169(148) fmol/ml for BNP, $p=0.021$ and 62(1)% vs 55(3)% for EF, $p=0.039$ }. Log(BNP) was inversely associated with post-operative EF, independently of age and baseline EF in a multiple regression model ($R^2=0.468$, $p=0.047$).

Conclusion: BNP has incremental value in the prediction of LV dysfunction following successful mitral repair surgery for degenerative valve disease.

9 OBJECTIVE ASSESSMENT OF PULMONARY REGURGITATION IN REPAIRED TETRALOGY OF FALLOT PATIENTS

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Introduction: The presence and severity of pulmonary regurgitation (PR) in repaired tetralogy of Fallot (rTOF) patients has been shown to be a factor in the reduced exercise performance experienced by these patients. Patients with restrictive right ventricular (RV) physiology have reduced PR therefore improved exercise haemodynamics. Apart from MRI there is no easily accessible non-invasive method of assessing the severity. We therefore looked at a group of adult rTOF patients with a view to defining a simple measurement to assess severity.

Method: All subjects underwent echocardiography prior to cardiopulmonary exercise testing. Images were digitally stored & analysed off line. Peak PR velocity (v), acceleration time (ac.t), deceleration time (dt), deceleration slope (dv/dt) and pressure half time (p1/2t) were measured & averaged from 3 cardiac cycles. Restrictive (R-) RV physiology was defined as antegrade flow in the pulmonary artery coinciding with atrial systole.

Results are expressed as mean (\pm SD). 26 rTOF subjects (31.08 \pm 9.42yrs) were investigated of which 13 had R-RV physiology. Peak PR v was reduced in the R-RV group (1.60 \pm 0.59 m/s v 1.98 \pm 0.33 m/s, $p<0.04$). There was no significant difference in dt, dv/dt or p1/2t between the groups. Peak PR v correlated with peak oxygen consumption (VO_2) ($r=-0.4$, $p<0.04$) & cardiac reserve ($r=-0.5$, $p<0.02$). dv/dt correlated with exercise time ($r=-0.5$, $p<0.01$), peak VO_2 ($r=-0.5$, $p<0.02$), peak cardiac output ($r=-0.6$, $p<0.01$) & cardiac output reserve ($r=-0.7$, $p<0.01$). dt correlated with peak cardiac output ($r=0.4$, $p<0.05$) and p1/2t with rest & percentage predicted heart rate ($r=-0.6$, $p<0.01$ & $r=-0.4$, $p<0.05$ respectively).

Conclusion: The reduction in peak PR v along with the negative correlation with peak VO_2 & cardiac reserve confirm the superior exercise haemodynamics experienced by the restrictive group. Deceleration slope and pressure halftime are independent of RV diastolic physiology yet both correlate significantly with exercise haemodynamics. This may prove an invaluable measurement in the continual assessment of these patients.

10 THE IMPACT OF DOBUTAMINE STRESS ECHOCARDIOGRAPHY (DSE) RESULTS ON PATIENT MANAGEMENT: DOES A POSITIVE DSE LEAD TO SUBSEQUENT INTERVENTION?

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DSE is a well-established technique for detecting reversible ischaemia and viable myocardium. However, the impact of a DSE result on patient management is less well documented. We performed a retrospective analysis of all patients undergoing a DSE over a 14-month period (April 2000-June 2001) at our institution. This was facilitated by utilising the Enconcert digital echocardiography storage system coupled with the search program Crystal Reports. In all patients undergoing a DSE, a search of the angiography database was also performed. In those not having angiography after a positive DSE, case notes were reviewed. 114 DSE were performed. 55 positive, 59 negative. Of the 55 positive DSE, 44 had angiography – 10 were part of a PMR trial and not included in this analysis. The DSE correctly predicted the territory of significant angiographic stenosis in 21/34. A positive DSE led to percutaneous intervention on the correctly identified culprit lesion in 16/21 (76%). Of the remaining 13 positive DSE, there was discordance between the DSE predicted territory and angiographic findings in 8 and 5 (14.7%) had a normal angiogram. 9 had a negative DSE with subsequent angiography – 5 were normal, 4 had significant single vessel disease (SVD) but no intervention was performed in light of the DSE result. A positive DSE led to revascularisation (PCI or CABG) in 19/34 (56%). Of the remainder most lesions were considered inappropriate for intervention or no longer clinically indicated. In conclusion, a positive DSE had a significant impact on patient management leading to revascularisation in just over half the cases. Conversely, where the DSE did not detect significant SVD, the result dictated that no intervention was undertaken. Finally, in three quarters of the cases where the DSE confirmed the physiological presence of a lesion, intervention was undertaken to that lesion.

11 HOW DO AGE AND HEART RATE AFFECT REGIONAL SYSTOLIC AND DIASTOLIC MYOCARDIAL FUNCTION?

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Background: Tissue Doppler echocardiography (TDE) allows the non-invasive accurate and objective assessment of regional left and right ventricular systolic and diastolic function, enabling subtle changes to be measured. Global left ventricular diastolic function, classically measured by transmitral pulsed wave Doppler flow, reduces with increasing age. It is not known whether this occurs uniformly across different myocardial territories. Systolic velocities are not thought to be normally influenced by the ageing process but do increase with heart rate.

Methods: 60 volunteers aged 20 to 80 were studied. All had normal ECGs and 2D echocardiograms and were not on any medications. Pulsed wave TDE images were obtained from the apical echocardiographic window and systolic (S) and early diastolic (E) myocardial velocities were measured at the septal (sep), lateral (lat) and inferior (inf) aspects of the mitral valve annulus and the free wall of the tricuspid annulus (RV).

Results: Heart rates varied between 55 and 100 beats per minute. Correlation coefficients (r) for the relationship between S and E velocities with age: sep(S) $r=-0.40$, $p=0.003$; sep(E) $r=-0.73$, $p<0.0001$; lat(S) $r=-0.26$, $p=0.06$; lat(E) $r=-0.71$, $p<0.0001$; inf(S) $r=-0.25$, $p=0.06$; inf(E) $r=-0.79$, $p<0.0001$; RV(S) $r=0.10$, $p=0.5$; RV(E) $r=-0.38$, $p=0.0039$. Correlation coefficients (r) for regional velocities as a function of heart rate in normals: sep(S) $r=0.5$, $p<0.0001$; sep(E) $r=0.06$, $p=0.6$; lat(S) $r=0.21$, $p=0.1$; lat(E) $r=0.13$, $p=0.3$; inf(S) $r=0.25$, $p=0.06$; inf(E) $r=0.07$, $p=0.6$; RV(S) $r=0.42$, $p=0.001$; RV(E) $r=0.16$, $p=0.2$.

Conclusions: In contrast to current thinking, left ventricular systolic function does in fact subtly decrease with normal ageing. This reduction is not apparent in the right ventricle. Hence, in the assessment of regional systolic function, both age and heart rate must be taken into account. Normal heart rate variation does not influence regional diastolic velocities and the changes seen with age appear to occur in a uniform fashion.

12 DISTURBANCE OF CARDIAC AND LARGE ARTERY FUNCTION IN HEART FAILURE.

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It has been proposed that altered pressure wave reflection, due to abnormalities of large artery function, could contribute to impaired cardiac function in heart failure (HF). Wave intensity analysis (WIA) is a recently described non-invasive technique that provides information on the working state of the heart, wave reflections, and arterio-ventricular interaction. Wave intensity is a measure of the energy carried by a wave and is the product of instantaneous changes in pressure and flow velocity at any arterial site. We used WIA to investigate the possibility of altered wave reflection and to further understand the haemodynamic changes that occur in HF. 29 patients with HF (NYHA class II-III, mean EF 35%) (60±9yrs) were compared to 29 age-matched subjects (60±9yrs) with normal systolic function (N). Brachial blood pressure, carotid arterial pressure (P) and flow velocity (U) were measured by sphygmomanometry, tonometry and pulsed wave Doppler respectively. The intensities of forward and backward waves and carotid pulse wave velocity (c) were calculated. Data are means ± SD, p was calculated by Student's t-test. P was lower in the HF group [129±21 (N); 120±24mmHg (HF); p=0.10]. c did not differ [13.6±5.5 (N); 13.2±6.3ms⁻¹ (HF)], suggesting that the elastic properties of the artery were unchanged. Peak U was significantly reduced in the heart failure group [0.70±0.15 (N); 0.56±0.17ms⁻¹ (HF), p=0.006]. Ventricular wave power was dramatically reduced in HF [29.2±9.8 (N); 15.4±7.7mWm⁻² (HF); p<0.00001], as was wave work [232±80 (N); 124±66 Jm⁻² (HF); p<0.00001]. Wave reflection from the head [13.3±7.5 (N); 17.5±11.7% (HF), p=0.08] and the body [1.5±1.7 (N); 5.4±6.1% (HF), p=0.001] were increased in the HF group. Heart failure is associated with a dramatic impairment in the ability of the heart to generate pressure waves. In addition wave reflection is increased, consistent with widespread vasoconstriction. This places an additional load on the ventricle that may further impair its function. WIA is a novel, simple way of providing important haemodynamic information in heart failure.

Moderated presentations

1 REPAIRED TOF PATIENTS HAVE NORMAL RV BUT ABNORMAL LV DEFORMATION

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Introduction: Strain imaging provides information on local myocardial deformation. Global left (LV) & right (RV) ventricular function is impaired to varying degrees in surgically repaired tetralogy of Fallot (rTOF) patients. Using strain imaging we assessed the local deformation characteristics of different regions of the LV+RV.

Method: rTOF patients were compared to normal controls. All subjects were imaged in the apical 2+4-chamber views superimposed with tissue Doppler imaging data. Longitudinal strain was calculated off line by placing the sample volume in the mid-ventricular and basal segments of the lateral, septal, inferior & anterior walls of the LV & the free wall of the RV. The results were averaged from 3 cardiac cycles.

Results are expressed as mean (±SD). 24 rTOF patients were compared to 15 age matched normal controls (31.38±10.38yrs v 32.07±9.87yrs, p=NS). There was no significant difference in strain between the basal+mid regions of the LV or RV in the normal population. In the rTOF group, strain was greatest at the base of the heart compared to the mid region in the RV (24.10±10.41% vs 17.3±9.05%, p=0.03), septum (25.75±8.32% vs 17.06± 5.66%, p<0.001), lateral (19.92±6.73% vs 15.07±6.93%, p<0.04), inferior (20.73±7.44% vs 15.86±5.31%, p<0.05) & anterior (22.23±8.56% vs 16.69±5.38%, p<0.05) walls of the LV. Basal strain of the LV was similar in both groups. However mid-septal (16.59±5.26% vs 24.07±10.54%, p=0.02), mid-lateral (14.97±7.06% vs 21.12±6.36%, p<0.01), mid-inferior (15.97±5.46% vs 21.53±6.92%, p<0.02) & mid-anterior (16.31±5.35% vs 20.75±5.50%, p=0.04) strain were significantly less. RV strain was similar to that of the normal population at both the basal & mid regions (24.65±10.31% vs 29.93±13.43%, p=NS and 16.99±9.14% vs 22.27±11.74%, p=NS, respectively).

Conclusion: Myocardial deformation of the RV is normal in rTOF subjects. However LV deformation is reduced. The pattern of abnormal

deformation of the LV is regional suggesting this may be the result of ischaemic injury at the time of repair.

2 TRANSCRANIAL DOPPLER OR TRANSESOPHAGEAL ECHOCARDIOGRAPHY FOR THE DETECTION OF VENOUS-TO-ARTERIAL CIRCULATION SHUNTS

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Background: Contrast transcranial Doppler ultrasound (TCD) is simple, non-invasive and detects both cardiac and pulmonary venous-to-arterial circulation shunts (v-aCS). We compared the TCD detection of v-aCS with transoesophageal echocardiography (TOE) for patent foramen ovale (PFO).

Methods: We studied 39 patients aged 15-39 following ischaemic stroke (33) or myocardial infarction (6). "Standardised" TCD was performed 2 weeks before "simultaneous" TCD and TOE. Agitated saline contrast was injected intravenously twice at rest and twice each with cough and Valsalva provocation. In standardised TCD, the patient sat up and the Valsalva manoeuvre was to a pressure of 40 mmHg for five seconds immediately after contrast injection. During "simultaneous" TCD and TOE the patient was in the left lateral position, coughing was difficult and Valsalva was by epigastric pressure.

Results: On TOE, 16 of the 39 patients had a PFO, all also having more than 15 microbubble emboli on TCD within 12 cardiac cycles of intravenous contrast injection. In 14 of the 16, paradoxical embolisation was spontaneous and did not need provocation on standardised TCD. The number of microbubble emboli, at a median (IQR) of 20 (3-135) on standardised TCD was uniformly higher than 7 (1-43) on simultaneous TCD and 13 (6-42) on TOE, perhaps due to sedation, the lying position or inadequate provocation. The size of the PFO on TOE correlated closely with the number of microbubble emboli on standardised TCD (rs = 0.83, [0.70, 0.91]).

Conclusions: TOE is relatively insensitive to v-aCS as it is difficult to achieve adequate cough or Valsalva provocation. Standardised TCD is sensitive to the detection of v-aCS and PFO with more than 15 microbubbles within 12 cardiac cycles universally detecting PFO.

3 BENEFITS OF ANGIOTENSIN CONVERTING ENZYME INHIBITION IN CARDIAC FAILURE

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Wave intensity analysis (WIA) is a novel non-invasive technique that measures the working state of the heart, pressure wave reflection and arterio-ventricular interaction. WIA allows forward and backward waves to be distinguished, where wave intensity (dI) is a measure of the energy carried by a wave. Angiotensin converting enzyme inhibition (ACEI) is beneficial in heart failure and has been shown to reduce peripheral resistance, wave speed (c), augmentation index (AI) and wave reflection. WIA was used to investigate the haemodynamic effects of ACEI. 15 patients with heart failure (NYHA class II-III) were studied on two occasions with and without ACEI. In addition to brachial blood pressure (BP) and ejection fraction (EF), carotid arterial pressure (P) and flow were measured by tonometry and pulsed wave Doppler respectively. Forward and backward wave intensities, forward and backward pressures, carotid c, and AI were calculated. Data are means±SD, p was calculated by a paired Student's t-test and data were log transformed where appropriate*. ACEI significantly reduced BP from 131±19/74±16 to 119±17/67±12 mmHg (p<0.001 systolic and p=0.02 diastolic). ACEI also caused a reduction in AI (-ACEI=26.3±10.7; +ACEI=21.7±13.7%; p=0.09*) and c (-ACEI=15.2±8.4; +ACEI=11.8±5.5 ms⁻¹; p=0.07). Wave reflections from the body (-ACEI=3.2±3.5; +ACEI=3.8±4.8%; NS) and head (-ACEI=17.2±10.8; +ACEI=18.8±9.9%; NS) were not affected by ACEI. ACEI significantly increased flow (-ACEI=0.59±0.20; +ACEI=0.66±0.17 ms⁻¹; p=0.03). Ejection fraction also increased with ACEI from 32±20% to 39±16% (p=0.001), without an increase in early forward wave intensity (dI+c1) (-ACEI=22.6±13.9 mWm⁻²; +ACEI=24.4±17.4 mWm⁻²; NS) indicating that relatively more cardiac power is invested in achieving ejection than increasing pressure. These data suggest that the major haemodynamic effect of ACEI is to decrease peripheral resistance and to enhance the heart's function as a flow source.

4 THE IMPACT OF HAND CARRIED ULTRASOUND DEVICES (HCU) IN THE CARDIAC OUTPATIENT CLINIC UPON THE REFERRAL PATTERNS TO THE ECHO DEPARTMENT

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Small, portable, low cost, easy to use HCU devices are now freely available. The aim of this study was to evaluate the potential role of these devices in the cardiac outpatient setting and to assess how their use influences referral patterns to the echo department. Over a 5-month period, 75 patients in the cardiac clinic underwent a targeted study using the Philips Optigo HCU device. For each assessment, a proforma was completed, detailing: reason for echo, chamber size, systolic function, colour Doppler findings, presence of pericardial effusion, duration of study and outcome of examination.

75 cases (33F, 42 M, av. age 46 years). Referred by GP (60), Physician (11), Surgeon (3), Anaesthetist (1). Reason for echo: LV function (17), valve disease (11), SOB (11), AF (10), ECG changes (7), hypertension (6), palpitations (5), chest pain (2), presyncope/syncope (2), other (4). Av. scan time 1.9 mins (range 2–5). Outcome of HCU echo: prevented formal echo request 55 (29 normal, 26 abnormal – 25 of these only mild valve disease or a LV function abnormality), confirmed need for formal echo 12 (1 normal, 11 abnormal), study performed when normally would not 7 (4 normal, 3 abnormal), non-diagnostic study (1).

In 55 out of 75 patients (73%), the results obtained from the Philips Optigo HCU device prevented a formal referral to the echo department. In 12 cases, the HCU findings confirmed the clinician's judgement for requesting a formal echo. In only 7 cases (9%) it was utilised when an echo would not normally be done. Thus, a brief examination (av. 1.9 mins) with a HCU device in the outpatient clinic can have a significant impact on referral patterns and hence workload, to the echo department, both by preventing a significant number of formal studies and also, by detecting an abnormality needing further assessment, confirming the need for a formal study.

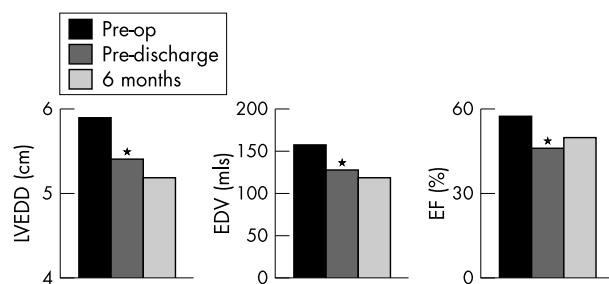
5 VENTRICULAR REMODELING FOLLOWING MITRAL VALVE REPAIR

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Background: There is limited information on the timescale of changes in left ventricular (LV) dimensions, volumes and systolic function in patients following mitral valve repair surgery.

Methods: We examined serial transthoracic echo studies of 40 consecutive patients with chronic severe mitral regurgitation (MR) 1 day prior to valve repair, then at 1 week and 6 months post surgery. LV end-diastolic diameter (LVEDD), volume (EDV), ejection fraction (EF) and regurgitant fraction (RF) were measured. The majority (35 patients) had degenerative disease.

Results: Baseline patient characteristics were: mean (SD) age 63 (13) years, 60% were male, 73% in sinus rhythm, 45% with EF>60% and 43% in NYHA grade III/IV. During follow-up 1 patient died and 2 had recurrence of severe MR (RF>55%). After 6 months EF was still significantly lower compared with baseline (mean (SD) EF 59 (8)% at baseline vs 50 (13)% at follow-up). There was an immediate reduction in LV EDV but a more gradual change in LV EDD as shown in the bar charts. This pattern of change was independent of age, pre-operative cavity size, EF, NYHA status or presence of coronary disease.



Conclusions: Following successful mitral repair there is an abrupt fall in end-diastolic volume but a gradual drop in mid-cavity diameter implying continued ventricular remodelling over several months.

6 MATERNAL CARDIAC FUNCTION IN TWIN PREGNANCIES: A MODEL FOR PREECLAMPSIA?

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The prevalence of pregnancy induced hypertension (PIH) and pre-eclampsia (PET) is increased in multiple pregnancies. Previous studies have demonstrated that PIH and PET are characterised by a hyperdynamic maternal circulation. It is possible that these changes also occur in normal twin pregnancies, but this has not been investigated before.

Methods: Echocardiography was performed in 125 singleton and 110 twin pregnancies at 10–42 weeks of gestation. Maternal cardiac output (CO) was the product of stroke volume and heart rate. Ejection fraction (EF) and fractional shortening (FS) reflected LV systolic function in the circumferential axis. The measurement of the displacement of the mitral annulus (MAD) towards the LV apex during contraction reflected LV systolic function in the longitudinal axis. Fourteen twin and 3 singleton pregnancies developed PIH or PET and were excluded from the analysis.

Results: The prevalence of hypertensive disorders was higher in twin compared to singleton pregnancies (11 % vs 2.3%, $p<0.01$). CO was higher in twin than in singleton pregnancies (8.2 vs 7 L/min, $p<0.0001$) as a result of higher stroke volume (100 vs 87.6 ml, $p<0.0001$) and heart rate (81.8 vs 80 bpm, $p<0.0001$). Mean arterial pressure (MAP) decreased until mid-pregnancy and subsequently increased towards term ($p_{\text{interaction}}<0.0001$ for both populations). However the increment in MAP in twin pregnancies took place earlier and more abruptly after mid-pregnancy, resulting in higher MAP values at term in twin versus singleton pregnancies ($p_{\text{interaction}}=0.03$). EF (0.69 vs 0.67, $p=0.007$) and FS (0.39 vs 0.37, $p<0.0001$) were higher in twin pregnancies throughout pregnancy. MAD mirrored the changes of MAP, increasing up to 25 weeks and then declining towards term. Similar to MAP, after mid-pregnancy there was a cross-over in MAD between singleton and twin pregnancies ($p_{\text{interaction}}<0.01$), suggesting an earlier compromise of longitudinal LV systolic function in twin versus singleton pregnancies.

Conclusions: In twin pregnancies even if uncomplicated, the maternal circulation is hyperdynamic and there is relative impairment in long axis function.

7 TISSUE DOPPLER ECHOCARDIOGRAPHY: A SIMPLE NON-INVASIVE METHOD TO OBJECTIVELY MONITOR RIGHT VENTRICULAR (RV) FUNCTION AFTER CABG

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Background: Tissue Doppler echocardiography (TDE) is a relatively new modality that permits the assessment of regional right and left ventricular function. Its main advantages over conventional echocardiography are that it 1) provides objective measures of systolic and diastolic function; 2) provides regional myocardial information; 3) is not dependant on image quality. RV dysfunction immediately after CABG is a recognised but poorly understood phenomenon. It is assumed that function improves back to normal with time after surgery. CABG on the beating heart without cardio-pulmonary bypass ('off pump') has gained increasing popularity. Improved post-operative ventricular function has been cited as an advantage over on pump surgery.

Methods: 30 patients (including 20 off pump cases) with 3-vessel coronary artery disease undergoing elective CABG each had pulsed wave TDI images obtained from the apex, visualising the tricuspid free wall annulus. RV systolic and diastolic velocities were compared immediately before, 5 days and 7 weeks after surgery. Regional mitral annular velocities were also studied for comparison.

Results: Each subject had a mean of 3.5 grafts. All had a graft to the right coronary artery. All left ventricular regional velocities showed a non-significant trend of improvement after surgery with time. Both systolic (S) and diastolic (E) velocities in the RV decreased considerably 5 days after CABG and this dysfunction continued to be present 7 weeks later: S pre 14.2 ± 1.2 , 5d $9.0\pm0.8^*$, 7w $7.6\pm1.0^*$. E pre 11.5 ± 0.7 , 5d $7.3\pm0.3^*$, 7w $5.7\pm0.8^*$ ($*p<0.01$). The off pump group had a similar trend with no evidence of preserved RV function compared to the on pump group.

Conclusions: Significant RV dysfunction is present 2 months after CABG and this may have important clinical implications. TDE can provide a simple, non-invasive quantitative method for assessing RV function and monitoring recovery after surgery.

8 TISSUE DOPPLER ECHOCARDIOGRAPHY AS AN ADJUNCT TO ASSESSING DIASTOLIC FUNCTION IN ESSENTIAL HYPERTENSION

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Background: The traditional assessment of diastolic function is limited by the way transmitral flow patterns vary as diastolic dysfunction becomes increasingly severe. It can be a challenge to easily separate normal from pseudonormal patterns.

Methods: In order to assess the prevalence of pseudonormal transmitral patterns in patients with uncomplicated essential hypertension we performed standard 2D and tissue Doppler echocardiography (TDE) in 127 patients. Using age matched normal data, we defined an E/A transmitral ratio of >1 coupled with a normal e wave deceleration time and a lateral wall E wave velocity below the 95% confidence interval as a pseudonormal picture.

Normal data for lateral wall e wave velocity used:

Age: [mean (95% confidence interval)]:
 Age: **40-49** [13.2 (12.5-13.9)] **50-59** [11.8 (11.1-12.40)];
60-69 [10.3 (9.4-11.1)] **>70** [8.0 (5.9-10.0)].

Results

1. NORMAL	n=27
E/A >1 and DT >150 ms with normal lateral E wave velocity	
2. RESTRICTIVE	n=2
E/A >1 and DT <150 ms (DT = E wave deceleration time)	
3. IMPAIRED RELAXATION	n=93
E/A <1	
4. PSEUDONORMAL	n=5
E/A >1 and DT >150 ms with reduced lateral e wave velocity	

Conclusion: Of the 32 patients who on traditional transmitral Doppler appeared to have normal diastolic function, five were found on TDE to have a significantly reduced E wave velocity, suggesting a pseudonormal picture. These patients have severe diastolic dysfunction. TDE velocities are easy to measure and are a useful adjunct in assessing diastolic function.

9 GLOBAL LV FUNCTION CAN BE ASSESSED USING ONLY ONE VIEW

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Peak mitral annular descent velocity using tissue Doppler imaging (TDI) provides an accurate assessment of left ventricular (LV) systolic and diastolic function. For assessment of global LV function, analyses of 4 walls (lateral, septum, anterior and posterior) is required. However this is time consuming. We feel this is a major reason why this modality is not used in routine clinical practice. We sought to see if 2-site sampling (lateral & septal) from the apical 4-chamber view, which is considerably less time consuming, would provide the same information.

Method: All subjects underwent TDI of the apical 2 & 4-chamber views with the sample volume placed over the lateral, septal, inferior and superior aspect of the mitral annulus. Peak systolic (S), early (E) and late (A) diastolic velocities were measured and averaged from 3 cardiac cycles. 2-site measurements were recorded as S2, E2 and A2 and 4-site as S4, E4 and A4. Images digitally stored & analysed offline. Measurements were averaged from 3 cardiac cycles.

Results are expressed as mean (\pm SD). 72 consecutive subjects, aged 45 ± 18.32 yrs, attending for routine echocardiography were scanned. There was no significant difference between measurements taken at 2 or 4-sites for peak S (6.28 ± 2.11 cm/s vs 6.32 ± 2.08 cm/s, p=NS), E (8.16 ± 3.39 cm/s vs 8.08 ± 3.19 cm/s, p=NS), A velocity (6.75 ± 2.60 cm/s vs 7.06 ± 2.66 cm/s, p=NS), or E/A ratio (1.35 ± 0.70 vs 1.29 ± 0.69 , p=NS). Excellent correlation was demonstrated between 2 & 4-site sampling in all patients for peak S ($r=0.98$, $p<0.001$), E ($r=0.97$, $p<0.001$), A velocity ($r=0.95$, $p<0.001$) and E/A ratio ($r=0.96$, $p<0.001$).

Conclusion: Apical 2-site sampling correlates significantly with 4-site sampling in patients with varying degrees of LV impairment. This method is considerably less time consuming. Apical 2-site sampling can be used to assess global LV function.